Docket 11739

GOLF CLUB WOODS WITH WOOD CLUB HEAD HAVING A SELECTABLE CENTER OF GRAVITY AND A SELECTABLE SHAFT

Mark C. Myrhum
Mitchell C. Voges

GOLF CLUB WOODS WITH WOOD CLUB HEAD HAVING A SELECTABLE CENTER OF GRAVITY AND A SELECTABLE SHAFT

[0001] This invention relates to wood golf clubs and, more particularly, to such wood golf clubs wherein the vertical center of gravity of the wood club head is selectable.

BACKGROUND OF THE INVENTION

[0002] The golf clubs that are used to hit the golf ball the greatest distances are the "woods". The woods originally were made of natural wood but today are made of metals or composite materials. However, they continue to be termed "wood golf clubs" or "woods", and that terminology is used herein.

[0003] The wood golf clubs have wood club heads with relatively large mass, and loft angles of the faces relative to the soles selected to achieve a long flight distance of the struck golf ball. A golf player typically carries up to five woods, which are distinct from each other in that the loft angle varies from about 7 to about 11 degrees for a driver wood golf club, and about 12 degrees and higher for other wood golf clubs. Of the golf clubs termed "woods", the drivers, with relatively low loft angles, are designed to hit the golf ball the greatest distances. The golfer selects the required wood golf club from this group of wood golf clubs. A wood golf club, and normally a driver, is used for most long shots from the tee, and may be used on intermediate shots on some longer holes.

[0004] As the game of golf has been studied analytically, it has become clear that the design of the wood golf club plays a part in the ability of the player to hit long, accurately directed shots. For example, the shapes of the wood club heads have been optimized. Large-sized wood club heads have been introduced. Wood club heads have been designed to allow the player to add weight to the wood club head.

[0005] While these approaches yield benefits, the present inventors have

observed that most players still cannot obtain wood golf clubs that are optimal for the individual. Players vary according to weight, height, strength, skill and other factors. Wood golf clubs may be purchased with varying shaft lengths, but the wood club heads themselves do not change, except as to the loft angle of the face and the ability to add weight to the wood club head in some designs. These approaches do not provide the required flexibility in selecting the wood club heads that are best suited to the individual player.

[0006] There is a need for an improved approach to the design of wood club heads, which allows the player to obtain wood golf clubs that are optimized for the individual. The present invention fulfills this need, and further provides related advantages.

SUMMARY OF THE INVENTION

[0007] The present invention provides a set of wood golf clubs and a method for selecting the wood golf clubs from this set that are best suited for the individual player. The set of wood golf clubs have different wood club heads with different vertical centers of gravity, while maintaining the other physical characteristics of the wood club heads unchanged. This variation permits the player to be tested with the different wood club heads and equipped with a wood club head of each loft angle that is best suited for the player. Additionally, the wood club heads are designed to allow different shafts to be used with the various wood club heads, so that the proper shaft may be matched to the proper wood club head.

[0008] In accordance with the invention, a set of wood golf clubs comprises a first wood club head having a first-club-head sole weight, a first-club-head crown weight, and a first club head total weight, and a second wood club head having a second-club-head sole weight, a second-club-head crown weight, and a second club head total weight. An external shape of the first wood club head and an external shape of the second wood club head are substantially the same, and the first club head total weight and the second club head total weight are substantially the same. The first-club-

head sole weight is greater than the second-club-head sole weight, and the first-club-head crown weight is less than the second-club-head crown weight. Preferably, each of the first wood club head and the second wood club head is formed of exactly two pieces, a wood club head body and a wood club head face with a joint therebetween.

[0009] In one embodiment, each of the first wood club head and the second wood club head displaces substantially the same volume, preferably about 335 cubic centimeters. In another embodiment, each of the first wood club head and the second wood club head weighs from about 195 grams to about 205 grams.

[0010] In one preferred form, each of the first wood club head and the second wood club head has no integral hosel. Each of the wood golf clubs further comprises a bore in the respective wood club head sized to receive a wood club shaft therein, and a threaded fastener that engages the respective wood club shaft to the respective wood club head, when the wood club shaft is inserted into the bore. At least one of the wood club heads has a wood club shaft affixed thereto by this approach.

[0011] The wood club heads are preferably "metal woods", wherein each of the first wood club head and the second wood club head is made of a metal alloy such as a titanium alloy. The wood club heads are preferably cast by an approach such as lost wax casting or die casting, so that the wood club heads have an as-cast microstructure, as distinct from a forged or otherwise worked microstructure.

[0012] In the approach of most interest, there is additionally a third wood club head having a third-club-head sole weight, a third-club-head crown weight, and a third club head total weight. The external shape of the first wood club head, the external shape of the second wood club head, and an external shape of the third wood club head are substantially the same. The first club head total weight, the second club head total weight, and the third club head total weight are substantially the same. The first-club-head sole weight is greater than the second-club-head sole weight, and the second-club-head sole weight is greater than the third-club-head sole weight. The first-club-head crown weight is less than the second-club-head crown weight, and the second-club-head crown weight is less than the third-club-head crown weight. The result of shifting the weight between the sole and the crown is to move the vertical center of gravity of the

club head. This three-club-head set thus may be characterized as having a low center-of-gravity wood club head, a medium center-of-gravity wood club head, and a high center-of-gravity wood club head, where low, medium, and high are measured vertically in a direction generally perpendicular from the sole of the wood club head.

[0013] A method for providing a wood golf club for a player comprises the steps of providing a first wood golf club for the player, the first wood golf club having a first wood club head with a first club head total weight and a first vertical center of gravity, analyzing the performance of the player using the first wood golf club, providing a second wood golf club for the player, the second wood golf club having a second wood club head with a second wood club head total weight substantially equal to the first wood club head total weight and a second vertical center of gravity different from first vertical center of gravity, and analyzing the performance of the player using the second wood golf club. These steps may be, and typically are, repeated for additional wood club heads and with a variety of wood club shafts. The wood club heads are preferably of the type described previously.

[0014] The "set" of wood club heads described herein are of the same loft angle, weight, shape, and other physical characteristics. They provide a variation of the vertical center of gravity for a selected loft angle. There would be a different set of wood club heads for a different loft angle of the wood club head. Thus, for example, in the low, medium, and high vertical centers-of-gravity cases and for the five standard wood golf club loft angles, there would be three wood club heads for each loft angle, for a total of fifteen wood club heads over the five loft angles. These various wood club heads may be assembled with shafts of any of a variety of lengths, stiffnesses, materials of construction, and the like, using the feature of the selectability of the shaft. This variability allows the player to be provided with many combinations of wood club types in order to determine which combinations are optimal for the individual.

[0015] Other features and advantages of the present invention will be apparent from the following more detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention. The scope of the invention is not, however, limited to this

preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Figure 1 is a perspective view of a wood golf club according to the invention;

[0017] Figures 2-4 are sectional views taken on line 2-2 of Figure 1, illustrating a preferred technique for adjusting the center of gravity of the wood club head;

[0018] Figures 5-7 are side sectional views, like those of Figures 2-4, and taken on line 2-2 of Figure 1, illustrating a second technique for adjusting the center of gravity of the wood club head;

[0019] Figure 8 is an enlarged, partially exploded, sectional view of the wood club head, taken on line 8-8 of Figure 1; and

[0020] Figure 9 is a block diagram of a method of providing a wood golf club for a player.

DETAILED DESCRIPTION OF THE INVENTION

[0021] Figure 1 depicts a wood golf club 20. The wood golf club 20 is sometimes termed a "wood" club or a "wood". The wood golf club 20 includes a wood club head 22 and a generally cylindrical wood club shaft 24 affixed to the wood club head 22. The wood club shaft 24 may be of any operable material of construction, such as metal (e.g., titanium, aluminum), composite (e.g., graphite/epoxy), or even natural wood; produced by any operable method; of any operable diameter; of any operable length; and of any operable physical properties (e.g., elastic modulus, strength). One of the features of the present invention, as will be discussed subsequently in relation to Figure 8, is that the wood club shaft 24 is readily interchangeable.

[0022] Figure 2 is a sectional view through the wood club head 22. In the preferred form, the basic structure of the wood club head 22 preferably includes two pieces, a one-piece wood head body 26 and a one-piece wood head face plate 28 affixed

to the wood head body 26 by a weldment 30, by an adhesive, or by other means for affixing. The wood head body 26 may be described in terms of two regions pertinent to the present discussion, a generally planar sole 32 that rests upon the ground 34, and a crown 36 that is visible to the eye of the player when the player holds the wood golf club 20 and looks downwardly toward the wood club head 22. The wood head body 26 is preferably hollow, and the crown 36 is convexly (outwardly) curved relative to the interior of the wood head body 26. The crown 36 is the convexly, outwardly curved portion of the wood head body 26 that is uppermost in Figure 2. The sole 32 is the lowermost portion of the wood head body 26 in Figure 2, which is flat over most of its area and slightly upwardly curved toward the left hand side of Figure 2 (remote from the wood head face plate 28). The sole 32 meets and is contiguous with the crown 36 on the left hand side of Figure 2.

[0023] The wood head body 26 may be made of any operable material, but is preferably made of a metal alloy such as a titanium alloy. The wood head body 26 may be made by any operable manufacturing process, but is preferably made by a casting technique such as lost wax casting or die casting. It may also be forged or machined. The wood head face plate 28 is made separately from the wood head body 26. The wood head face plate 28 is preferably also a metal alloy such as a titanium alloy, but a different alloy composition than used in the wood head body 26. The wood head face plate 28 is preferably forged. After the wood head body 26 and the wood head face plate 28 are fabricated separately, they are joined by fitting the wood head face plate 28 into a recess formed on the wood head body 26 and then welded, adhesively bonded, or otherwise attached in place by the weldment 30 that extends around the periphery of the wood head face plate 28.

[0024] The inventors have determined that an important performance characteristic of the wood golf club 20 is a vertical location of a center of gravity 38 of the wood head body 26. The "vertical location" is a distance D_{CG} from an external surface 40 of the sole 32 toward the crown 36 measured along a line 42 perpendicular to the planar portion of the sole 32.

[0025] Figures 2-4 illustrate three wood club heads 22 for a set of wood golf

clubs 20. These three wood club heads 22 of Figures 2-4 have substantially the same external shapes and volumes. The three wood club heads 22 also have substantially the same total weights. The shapes, volumes, and weights of the three wood club heads 22 in this set of wood golf clubs 20 are substantially the same in order to allow optimization of the selection of the vertical location of the center of gravity 38, without simultaneously varying other parameters such as shape, loft angle, and total weight of the wood club head 22.

[0026] The vertical locating of the center of gravity 38 of the three wood club heads 22, while maintaining the limitation of substantially constant external shape, volume, and total weight, may be accomplished by any operable approach. Figures 2-4 illustrate a preferred approach, changing the thicknesses of the sole 32 and the crown 36 to redistribute weight and move the center of gravity 38 vertically. The thickness changes and the movement of the center of gravity 38 are quite small and may be difficult to discern in precisely scaled drawings, so in Figures 2-4 the thickness variations and the vertical displacement of the center of gravity 38 are exaggerated. In the wood club head 22 of Figure 2, a thickness t_S of the sole 32 is relatively large, and a thickness t_C of the crown 36 is relatively small, so that the weight of the sole is relatively large and the weight of the crown is relatively small. Consequently, the center of gravity 38 is relatively low (i.e., near to the sole 32). (The exact locations where the thickness of the sole and the thickness of the crown are measured is not critical, as long as they are generally in the centers of the respective regions and are consistently positioned from wood club head to wood club head within a set.) The weight of a region such as the crown or the sole generally correlates with its thickness within this set of club heads, so that the thicker the region, the greater its weight. In the wood club head 22 of Figure 3, the thickness t_S of the sole 32 is smaller than that of the wood club head 22 of Figure 2, and the thickness t_C of the crown 36 is greater than that of the wood club head 22 of Figure 2. The result is that the center of gravity 38 of the wood club head 22 of Figure 3 is higher (i.e., further from the sole 32) than the center of gravity 38 of the wood club head 22 of Figure 2. In the wood club head 22 of Figure 4, the thickness t_S of the sole 32 is smaller than that of the wood club head 22 of Figure

3, and the thickness t_C of the crown 36 is greater than that of the wood club head 22 of Figure 3. The result is that the center of gravity 38 of the wood club head 22 of Figure 4 is higher (i.e., further from the sole 32) than the center of gravity 38 of the wood club head 22 of Figure 3. The wood club head 22 of Figure 2 is termed the "L" (low) center of gravity variation, the wood club head 22 of Figure 3 is termed the "M" (medium) center of gravity variation, and the wood club head 22 of Figure 4 is termed the "H" (high) center of gravity variation. More variations in the vertical location of the center of gravity 38 may be provided than the three illustrated, but initial testing indicates that three variations are sufficient for most applications. The changes in thickness of the sole 32 and of the crown 36 in each case are selected so that the total weight of the wood club head 22 remains the same. The changes in thickness are accommodated by varying the position of an inner wall 44 of the wood club head 22, so that the shape of an outer wall 46 remains unchanging.

[0027] The wood head bodies 22 of Figures 2-4 are preferably manufactured by a lost wax casting approach. This technique is known generally for the manufacture of hollow golf club head bodies of other designs, see for example US Patent 5,429,365. Generally, there is an outer casting shell that defines the position, shape, and size of the outer wall 46, and a casting core that defines the position, shape, and size of the inner wall 44. In the present case, the outer casting shell used for the three wood club heads 22 of Figures 2-4 is the same, so that the wood head bodies 22 have the same external shape, loft angle, and volume, about 335 cubic centimeters in the preferred approach. The casting cores used to cast the three wood head bodies 26 have a constant volume, so that the total amount of metal (and thence the weight) in each of the wood head bodies 26 is a constant amount, preferably in the range of from about 195 to about 205 grams in the preferred approach wherein the wood head bodies 26 are cast from the titanium alloy titanium-6 weight percent aluminum-4 weight percent vanadium. The casting cores are differently positioned, so as to define the thicknesses of the sole 32 and the crown 36 in the manner discussed previously to produce the three different types of wood club heads 22 of Figures 2-4.

[0028] Once the outer casting shell and the casting core are positioned, molten

metal is poured into the space therebetween and cooled to solidify and to form each of the wood head bodies 22. Any operable castable material may be used, but a titanium alloy such as titanium-6 weight percent aluminum-4 weight percent vanadium is preferred. After the cast metal has solidified, the outer casting shell and the casting core are removed, leaving the final hollow cast wood club head 22 having a cast microstructure. In alternative fabrication techniques, such as a forged or a machined microstructure, the final wood club head 22 has a corresponding microstructure such as a forged or a machined microstructure, respectively.

[0029] Other operable techniques for changing the vertical location of the center of gravity 38 may be used, and Figures 5-7 illustrate one such alternative approach. The pertinent parts of the prior discussion of the embodiments of Figures 2-4 are incorporated here. In the embodiment of Figures 5-7, a sole fitting 48 is formed in the sole 32, and a crown fitting 50 is formed in the crown 36. These fittings 48 and 50 are externally accessible. A corresponding sole weight insert 52 and a crown weight insert 54 are inserted into the respective sole fitting 48 and crown fitting 50. In a preferred version of this embodiment, the fittings 48 and 50 are female-threaded fittings, and the weight inserts 52 and 54 are matching male-threaded weights. The weight inserts 52 and 54 may be readily installed, removed, and moved in various combinations. The total weight of the sole weight insert 52 and the crown weight insert 54 is maintained constant, so that the total weight of the wood club heads 22 of Figures 5-7 remains constant.

[0030] The approach of Figures 2-4 has the advantage that the weight change is distributed broadly over the sole and the crown. The approach of Figures 5-7 has the advantage that the weight inserts 52 and 54 may be readily changed. The approach of Figures 5-7 has the additional advantage that the total of the weight inserts 52 and 54 may be readily changed, if desired.

[0031] The wood club heads of Figures 2-4 and 5-7 are illustrated as being conventional in configuration, except for the ability to change the vertical location of the center of gravity. Other modifications that have been found or may be found useful in wood club heads, such as changes in external shape or total weight, or material of

construction, may be utilized in conjunction with the present approach.

[0032] The approaches of Figures 2-4 and Figures 5-7 are used to change the vertical location of the center of gravity 38. Another factor that significantly influences the performance of the wood golf club 20 is the nature of the wood club shaft 24. Figure 8 illustrates an embodiment of the present approach that allows various types of wood club shafts 24 to be used with the variations of Figures 2-4 and Figures 5-7. The preferred wood club head 22 of the present approach has no integral hosel, which is a tubular portion that extends upwardly from the crown 36 of the conventional wood club head. The wood club shaft of the conventional wood club is inserted into the hosel and affixed to the hosel with an adhesive such as an epoxy.

[0033] In the present approach as seen in Figure 8, the wood club head 22 has no hosel, but instead has a bore 60 fabricated into the wood head body 26. The bore 60 has a base 62 that defines the bottom of the bore 60. An aperture 64 extends through the base 62. The bore 60 is sized to receive a hosel fitting 66 affixed to an end 68 of the wood club shaft 24. (The hosel fitting 66 is not integral with the wood club head 22.) The bore 60 is oriented in the wood club head 22 so that the wood club shaft 24 has the proper orientation to the wood club head 22 and to the wood head face plate 28. A fastener, preferably a male-threaded fastener 70 such as the illustrated bolt, extends through the aperture 64 of the base 62 to engage the female-threaded hosel fitting 66, and thence the wood club shaft 24, to the respective wood club head 22, when the hosel fitting 66 is inserted into the bore 60. The sole 32 is locally recessed at recess 72 so that the head of the fastener 70 does not strike the ground 34 when the wood golf club 20 is swung. With this approach, the wood club shaft 24 may be readily changed so that different shafts may be tested and possibly used with the various wood club heads 22. Shafts of different lengths, diameters, materials of constructions, elastic properties, and other characteristics may thence be utilized.

[0034] An important application of the present approach is to maximize the performance of the golf player for the wood golf clubs, by providing the optimal wood golf club equipment for the individual player. Figure 9 illustrates this approach. A wood golf club of a test configuration is provided, numeral 80. The performance of the

wood golf club test configuration when used by the particular player is analyzed, numeral 82. The steps 80, 82 are repeated, numeral 84, for a new test configuration, and may be repeated as many times as necessary to determine the optimum performance of the player as a function of the several variables that may be evaluated. Variables that may be included in the evaluation include the wood club head 22 and particularly the vertical location of the center of gravity of the wood club head, as discussed above, the type of drive club shaft 24 that is installed to the wood club head 22, and the type of golf ball being hit. This procedure would be used for a first set of wood golf clubs with a constant selected loft angle, and then may be used for additional sets of wood golf clubs with a different (but constant within any one set) loft angle. The present procedure is expected to yield the most benefits for the wood golf clubs with the lowest loft angles, termed the "drivers", but it may be used as well for other wood golf clubs.

[0035] The following performance tables for golfers A, B and C, employees of the assignee, were developed by the procedure of Figure 9 during the initial testing of the present approach. Each entry in the tables represents the average of multiple hits of a single commercial brand of golf ball. Performance was evaluated using a standard Launch Monitor device for analyzing golf ball movement. In each case, the golfer used three wood golf clubs 20. The wood club head 22 in each case was a 335 cubic centimeter, 200 gram, 7.5 degree loft angle club. The variation between the wood golf clubs was a low (L), medium (M), or high (H) vertical position of the center of gravity 38. The following table gives the approximate thicknesses, measured in inches, of the sole 32 and the crown 36 at the same respective point on each wood club head, and the resulting vertical position of the center of gravity in millimeters

Club Ident.	Sole Thickness	Crown Thickness	Center of Gravity
H	0.040	0.060	32
M	0.050	0.050	30
L	0.060	0.040	28

[0036] In the following performance tables, the table entries are, from left to right, the wood club head identification (L, M, or H), the initial launch speed (Vo) of the ball in miles per hour, the spin rate (SR) of the ball in revolutions per minute, the launch angle (LA) of the ball in degrees, the carry distance (CD) on the fly of the golf ball in yards, and the total distance (TD) of the golf ball on the fly and rolling, in yards.

Golfer A

Club Ident	Vo	SR	LA	CD	TD
H	160.5	2066	8.6	228.7	265.4
M	160.3	2163	9.4	237.9	268.2
L	161.2	2436	9.7	239.0	271.9

Golfer B

Club Ident	Vo	SR	LA	CD	TD
H	158.9	1992	9.9	229.8	266.2
M	158.8	2263	10.0	233.7	267.8
L	159.7	2745	10.2	240.5	271.1

Golfer C

Club Ident	Vo	SR	LA	CD	TD
H	161.4	3169	14.8	250.9	276.7
M	159.5	3400	15.3	247.8	272.2
L	160.1	3384	16.3	248.7	272.8

[0037] The results set forth in these tables are not to be interpreted as good or bad, consistent or inconsistent. These results simply reflect the performance of each individual player using various types of wood club combinations and for a single type

of golf ball.

[0038] In these data, Golfers A and B each achieves the greatest carry distance and total distance with the low center of gravity wood club head. Golfer C, on the other hand, achieves the greatest carry distance and total distance with the high center of gravity wood club head. Based on this data, the selection of wood club heads for Golfers A and B would be different than for Golfer C. These extremely limited data are presented to illustrate the operation of the present approach. In practice, much more data would be gathered for each player, including the effects of variations in the shape and volume of the wood club head, the weight of the wood club head, the loft angle of the wood club head, the type of wood club shaft, the materials of construction of the wood club shaft and the wood club head, the golf ball played, and even other features available in wood club heads.

[0039] This approach may be used in a custom-fitting procedure to find a single wood golf club that is optimal for that player, taking into account all of the variables discussed above. Once that single wood golf club is identified, then the illustrated version with the removable shaft (Figure 8) may be used by the player. To make the illustrated embodiment into a permanent wood golf club, the hosel fitting 66 may be fixed in place with a permanent adhesive, and a cap may be fitted over the head of the fastener 70 and fixed in place with the permanent adhesive. In other cases, other variables may be considered: wind conditions, launch angle, heel/toe properties, side spin, accuracy relative to an axis, distance accuracy, face mapping, and the like. Thus, for example, a number of golf clubs may be identified for use by the player, such as a wood golf club driver for use in still air conditions, a wood golf club driver for use in headwinds, a wood golf club driver for use in tailwinds, and the like.

[0040] Although a particular embodiment of the invention has been described in detail for purposes of illustration, various modifications and enhancements may be made without departing from the spirit and scope of the invention. Accordingly, the invention is not to be limited except as by the appended claims.